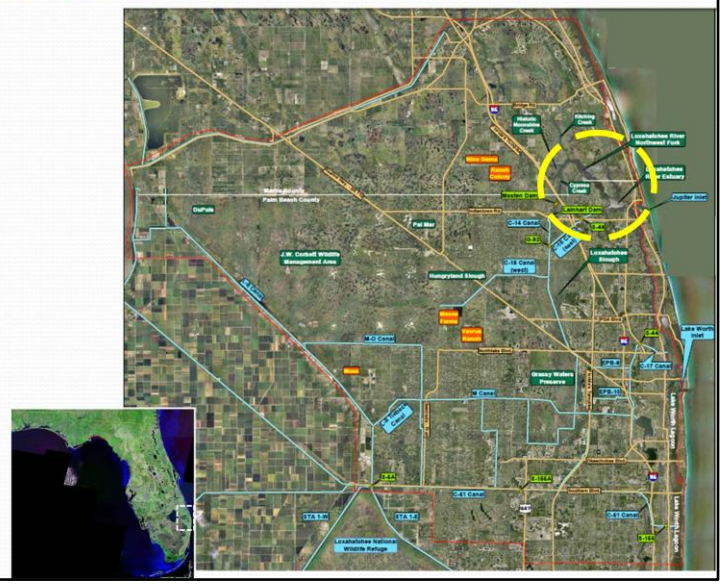
Florida Habitat Shifts Due to Sea Level Rise

Northwest Fork of the Loxahatchee River

Final Project

28 November 2012

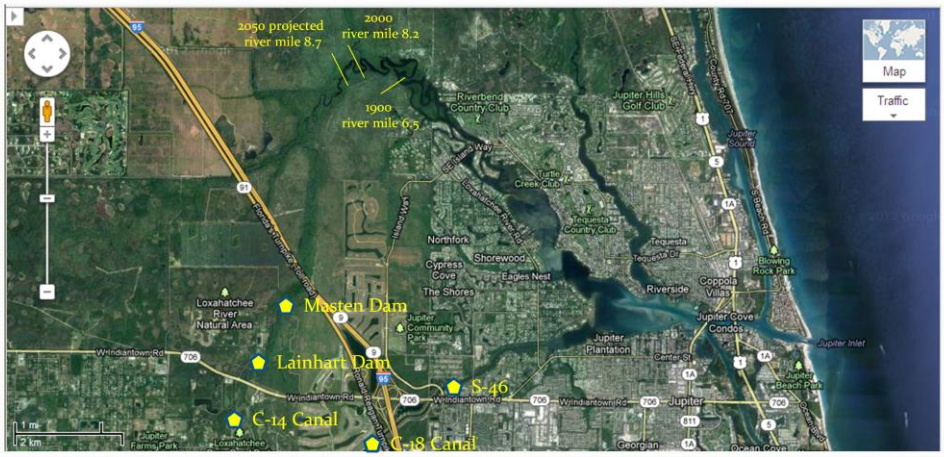
Project Location



Problem Background

- The mid to upper reaches of the Northwest Fork of the Loxahatchee River are now more saline than in the past and vegetative communities along certain river reaches are transitioning from the historic cypress swamp and associated freshwater wetland communities into mangroves.

Mangrove Encroachment & NWFLR Features



Decision Makers

- The project is managed by the US Army Corps of Engineers and their non-federal partner, the South Florida Water Management District.
  - 50-50 cost share agreement
- Project Delivery Team (PDT) consists of representatives from the Corps, SFWMD, USFWS, DEP, FFWCC, FDACS, and local government agencies.
  - PDT assists in developing and evaluating the alternatives. Each agency has their own regulatory handle on the project.

Why is this area important?

- The area is an important recreational destination and offers boating, canoeing, fishing, hiking, biking, camping, and other opportunities. In 2000, outdoor resource-based recreational demand for biking, fishing and hiking exceeded supply. Future demand for recreational resources is expected to increase.

Why is this area important?

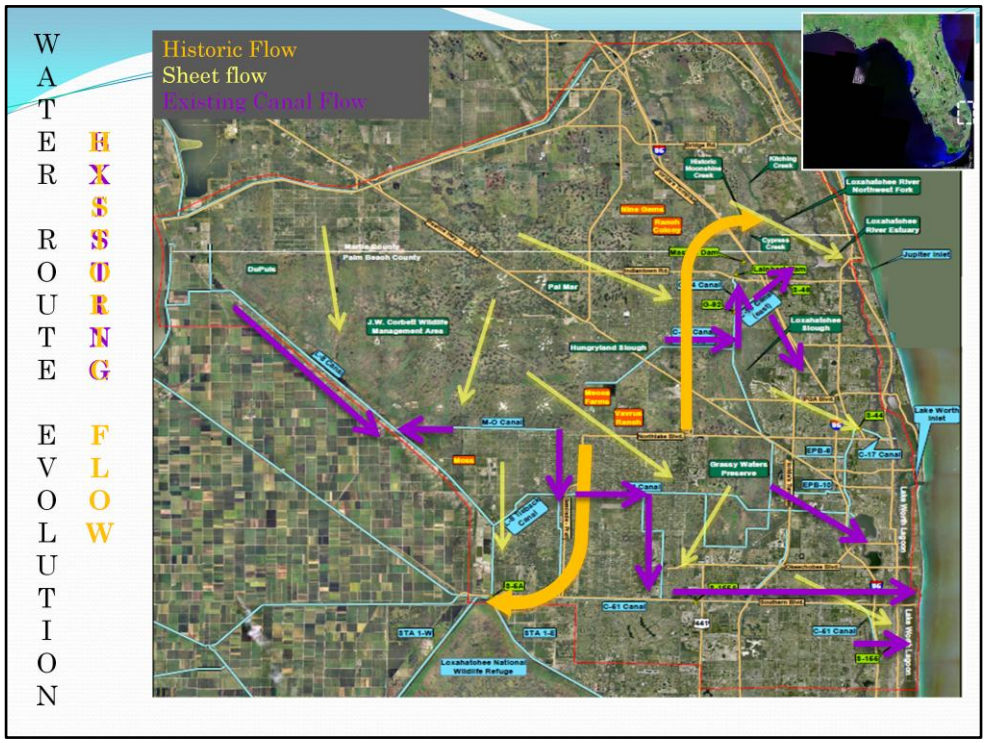
- The Northwest Fork of the Loxahatchee River is one of Florida's two federally designated National Wild and Scenic Rivers.
- The freshwater floodplain of the Northwest Fork represents the last vestige of pristine subtropical cypress swamp habitat within southeast Florida.

Decisions

- The decisions faced by this team include the value of different habitats (cypress vs. mangrove), the effort needed to retain an existing habitat versus allowing the habitat to transition, and the tradeoffs involved (freshwater river vs. estuary).

Problem Components

- Inadequate freshwater flows to the Northwest Fork.
  - The current landscape has been modified by water control structures to make it suitable for agriculture and residential development.
  - Between 1957-1958 the Corps constructed the C-18 canal, channelized the Southwest Fork and constructed the S-64 structure for flood control purposes. These improvements diverted freshwater flows from the Northwest Fork.
  - Decreased freshwater flows in the river have likely allowed for increased saltwater intrusion up the basin.

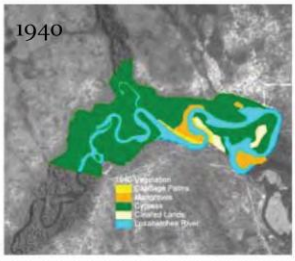

WATER ROUTE EVOLUTION
EXSSTURNG FLOW
Historic Flow
Sheet flow
Existing Canal Flow
Loxahatchee River Northwest Fork
Loxahatchee River Estuary
Jupiter Inlet
Palm Beach County
Pal Mar
J.W. Corbett Wildlife Management Area
Hungryland Slough
Loxahatchee Slough
M-O Canal
C-17 Canal
Lake Worth Inlet
Lake Worth Lagoon
Grassy Waters Preserve
C-51 Canal
STA 1-W
STA 1-E
Loxahatchee National Wildlife Refuge

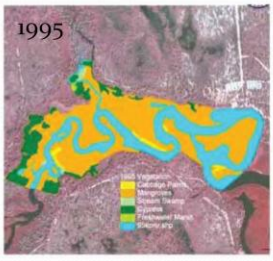
Problem Components

- Damaging releases of freshwater to Loxahatchee Estuary during storm events.
  - The improvements to Jupiter Inlet in the 1920s opened the Loxahatchee Estuary to increased tidal influences. The lower Loxahatchee River system has transitioned from a freshwater basin into an tidally influenced estuary.
  - High flow events during storms result in a pulse of freshwater entering the estuary potentially causing harm to oyster and seagrass communities.
  - Seagrass and oyster beds are important ecological resources in the estuary.

Sea Level Rise Considerations

- Sea level is rising at a rate of 8.85 inches over the last 100 years along the east coast of Florida. This is above the global average of 7.87 inches per 100 years.
- The rising sea level has increased the range of tidal influence in the project areas.

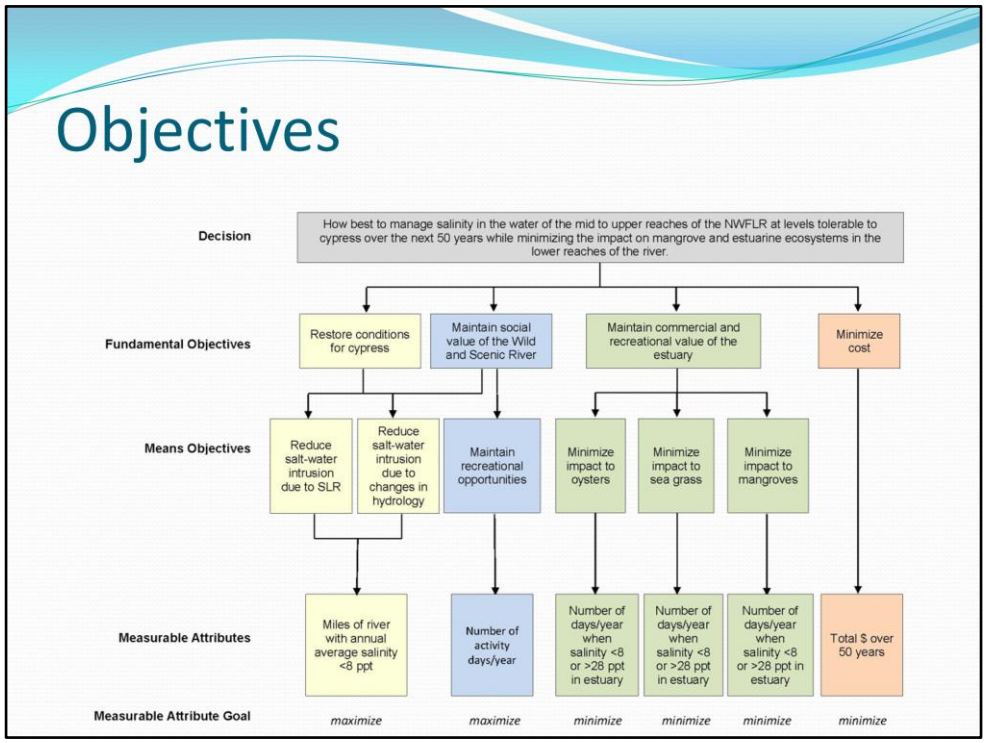




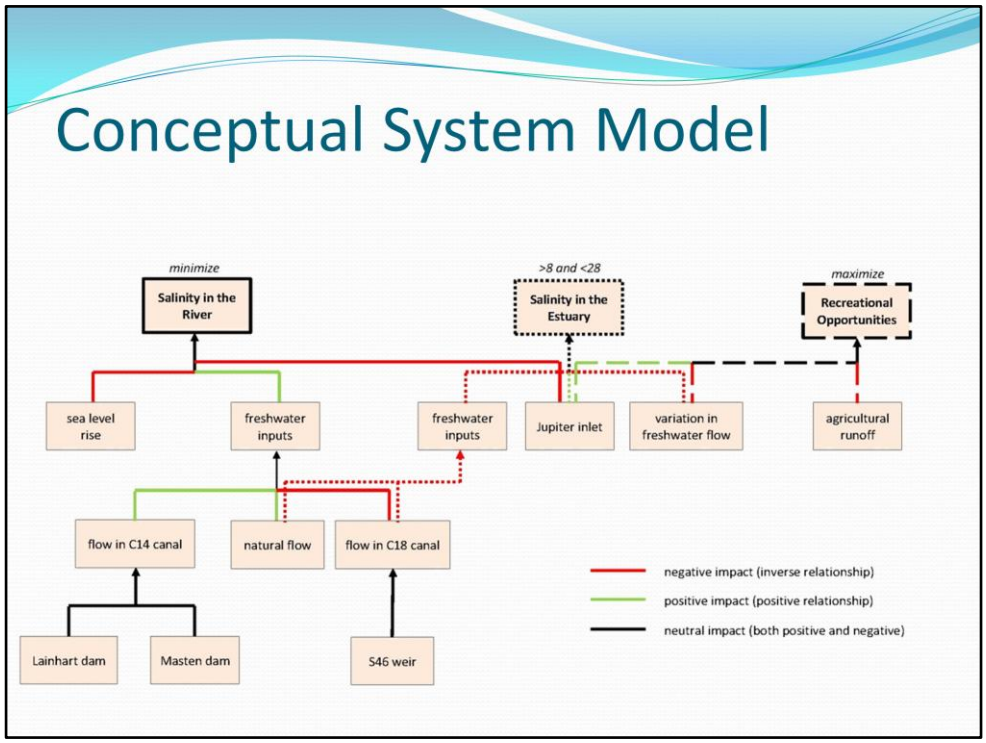
Sea Level Rise Considerations

- If historic trends in sea level rise continue, sea level is expected to rise an additional 5.5 inches by 2050.
- If we use the mean projected sea level rise (50% probability), we can expect an additional 9.8* (18.4^) inches of sea level rise by 2050.
- There is a 1% probability of an additional 19.3* (39.1^) inches of sea level rise by 2050.

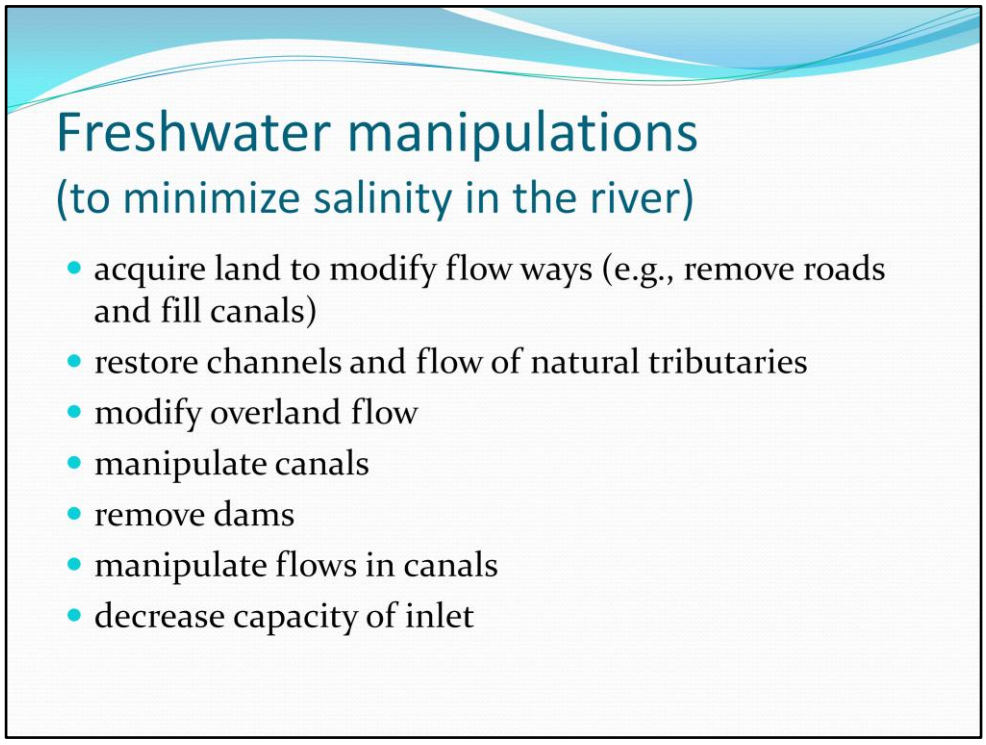
* * Sea level projections based on Corps EC 1165-2-211.
* ^ Sea level projections based on USFWS & MIT study.



Our objectives hierarchy from last week – remember what our objectives were



We created an influence diagram to understand what influences for each of our objectives.



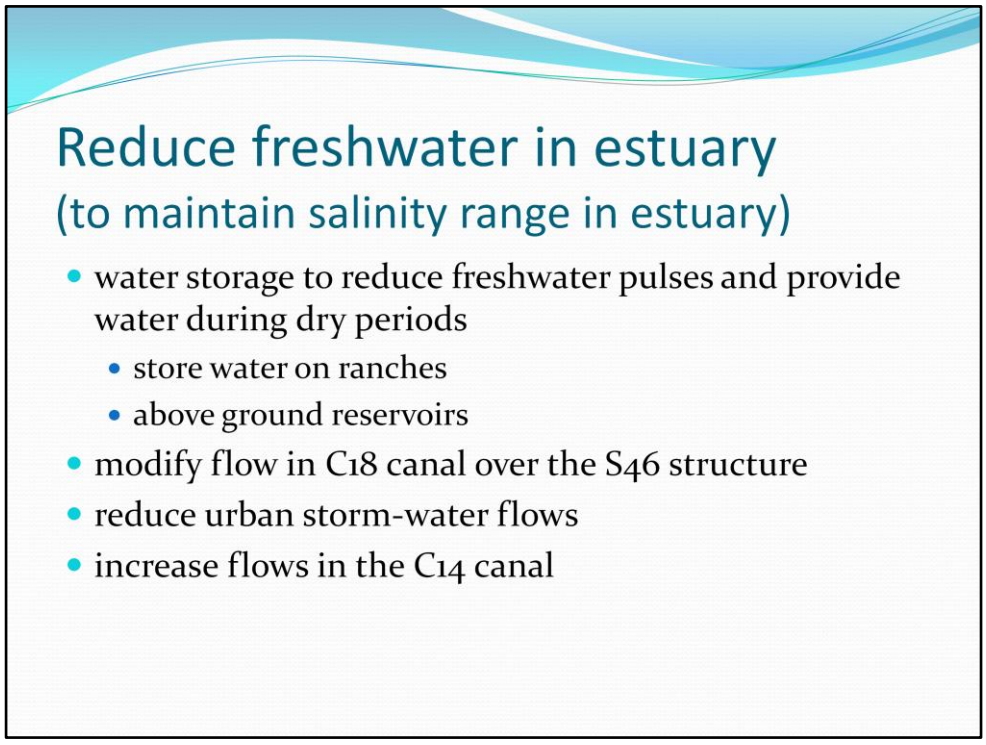
Then…we brainstormed a large list of possible alternatives to address each objective

These are the FRESHWATER MANIPULATION alternatives we came up with to minimize salinity in the river

Sea level rise
(to minimize salinity in the river)

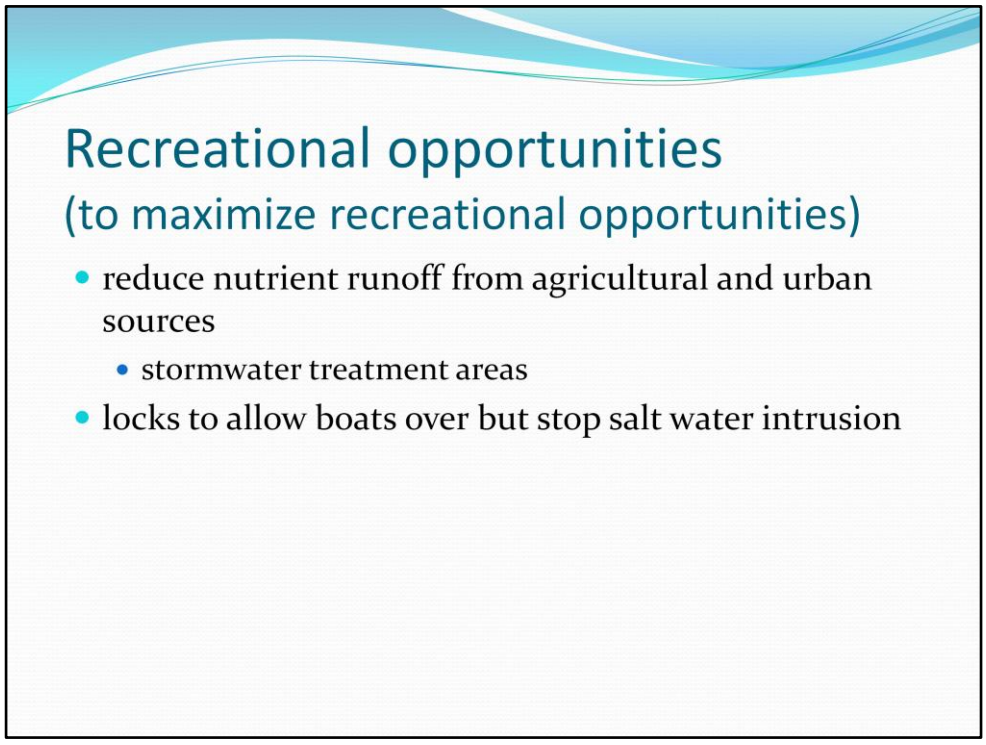
- underwater weir to block salt water from moving up (allows movement of manatees and boats; does not require operations, is a passive feature)
- desalination plant
- tide gates (restricts movements and requires operations)
- locks to allow boats over but stop salt water intrusion (restricts movements and requires operations)

These are the SLR alternatives we came up with to minimize salinity in the river



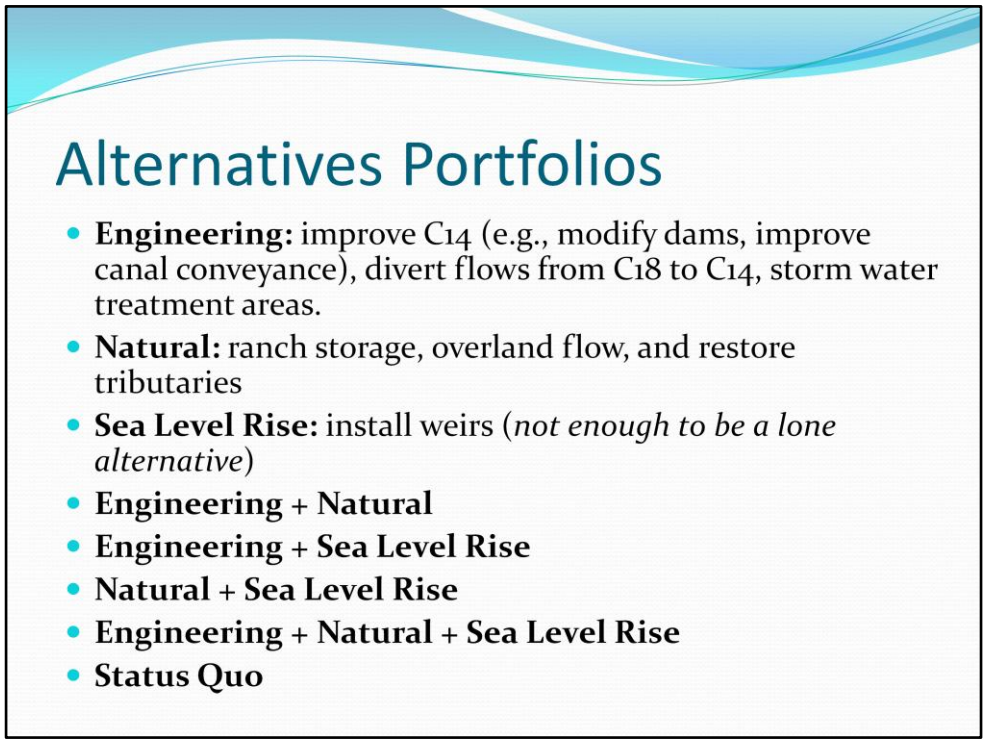
These are the REDUCE FRESHWATER IN ESTUARY alternatives we came up with to maintain salinity in the estuary at greater than 8ppm and less than 28 ppm.

Bullet 3 – "modify flow" means….reduce storm related freshwater flows in C18 canal over the S46 structure to reduce damaging freshwater pulses to the estuary



And….these are the RECREATIONAL OPPORTUNITIES alternatives we came up with to maximize rec opportunities

Stormwater treatment areas are one opportunity to manage/reduce nutrient runoff



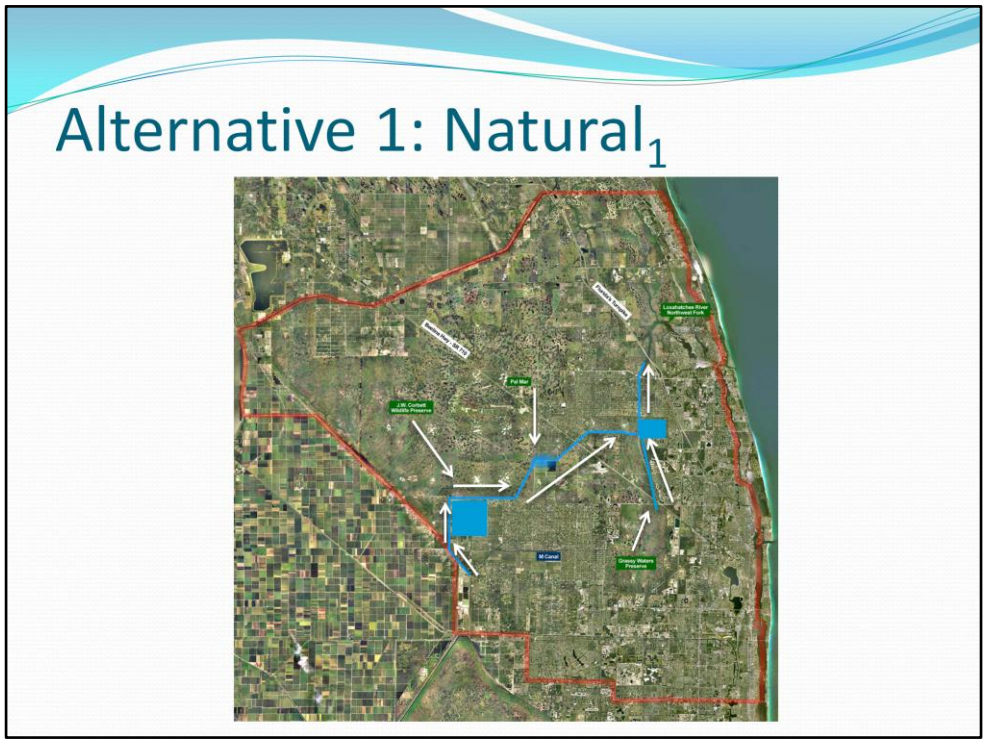
And then…we developed a suite of alternatives portfolios

We covered a wide variety of alternatives in a wide set of categories - tried to develop a good set of tools in our tool box

Status Quo portfolio is unique and addresses feedback we received from class

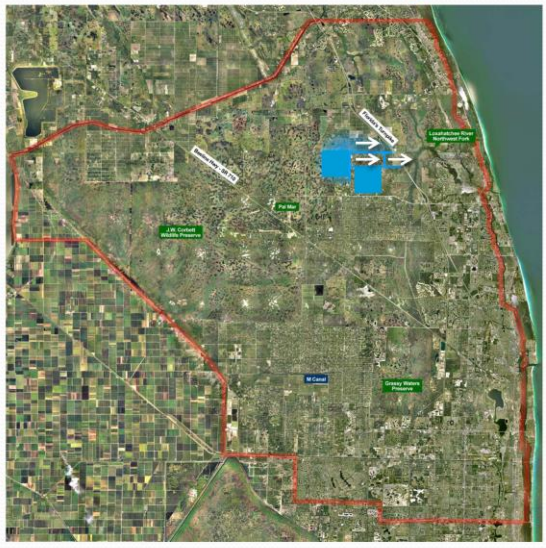
Alternatives

- Out of the alternative portfolio the team chose four discrete but combinable alternatives.
  - Natural1
  - Natural2
  - Engineering
  - Sea Level Rise (weir)



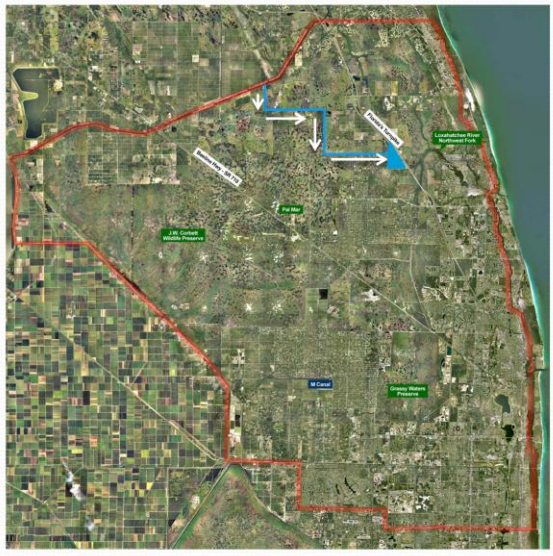
The Natural1 Alternative consists of water storage in Corbett Wildlife Management Area, Pal Mar, Grassy Waters Preserve, and Loxahatchee Slough. Water is transported to C-18 and C-14 and then to the NWFLR. These lands are already in public ownership. This alternative will
provide sufficient water to maintain minimum flows necessary to reduce salt water encroachment in the NWFLR. Total cost of this alternative is $24 million.

Alternative 2: Natural$_2$



The Natural2 Alternative consists of water storage in above ground reservoirs on Gulfstream Ranch (1,400 acres) and Shiloh Farms (390 acres). Gulfstream Ranch will supply water to Cypress Creek and Moonshine Creek. Shiloh Farms will supply water to C-14 Canal. Additional
storage is located on Nine Gems (3,100 acres), Pepper Farm (329 acres), and Culpepper (1,280 acres) parcels. The other properties would serve as overland flow and ranch storage supplying the above ground storage features. Most of these lands are in private ownership. This alternative
will result in restoration to Cypress Creek and Moonshine Creek, tributaries of the NWFLR as well as providing natural buffers to the NWFLR. This alternative will provide sufficient water to maintain minimum flows necessary to reduce salt water encroachment in the NWFLR. Total cost
of this alternative is $245 million.

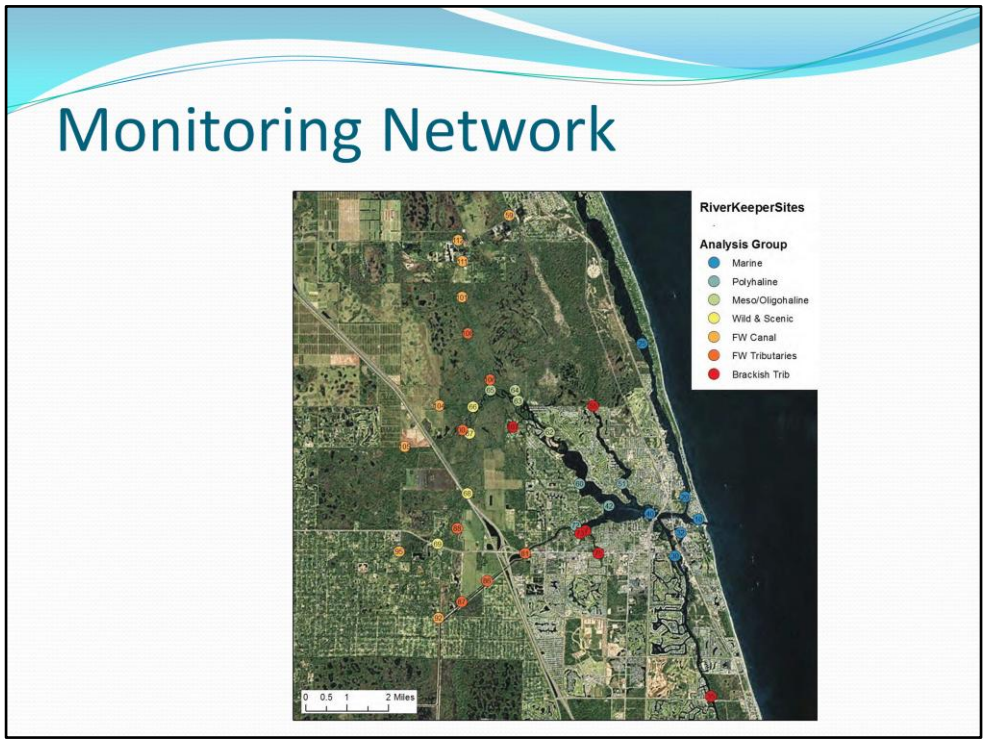
Alternative 3: Engineering



The Engineering Alternative consists of canal improvements and the construction of a Stormwater Treatment Area (STA) located between the C-44 canal and NWFLR. This alternative will result in improvements to Cypress Creek and Moonshine Creek, tributaries to NWFLR. This alternative will provide sufficient water to maintain minimum flows necessary to reduce salt water encroachment in the NWFLR. Total cost of this alternative is $117 million.

Alternative 4: Sea Level Rise

- This alternative consists of a submerged weir placed across the NWFLR. The purpose of the weir is to restrict salt water movement up the river.
  - Since salt water is more dense than freshwater the weir will hold back much of the denser salt water while still allowing the freshwater to flow over it.
  - A submerged weir will allow recreational activities, such as boating and canoeing, to continue on this section of the river.



The NWFLR has an extensive monitoring network which will be used to determine the effectiveness of the selected alternative.

Alternatives Ranking

	Alternatives															
Suggested Measurable Attribute	**Natural 1**	**Natural 2**	**Engineering**	**Sea Level Rise (SLR)**	**Natural 1 + Engineering**	**Natural 2 + Engineering**	**Natural 1 + SLR**	**Natural 2 + SLR**	**Engineering + SLR**	**Natural 1 + Engineering + SLR**	**Natural 2 + Engineering + SLR**	**Natural 1 + Natural 2**	**Natural 1 + Natural 2 + Engineering**	**Natural 1 + Natural 2 + SLR**	**Everything**	**Status Quo**
River miles with salinity <3 ppt	0.42	0.39	0.35	0.14	0.52	0.52	0.40	0.42	0.38	0.52	0.53	0.57	0.63	0.57	0.65	0.00
# days when water depth outside useable levels	0.33	0.32	0.25	0.00	0.40	0.35	0.33	0.32	0.25	0.40	0.35	0.45	0.51	0.45	0.51	0.00
# days algae concentration above threshold	0.38	0.33	0.33	0.00	0.41	0.37	0.38	0.33	0.33	0.41	0.37	0.43	0.52	0.43	0.52	0.00
# of days turbidity above threshold	0.25	0.22	0.18	0.00	0.26	0.23	0.25	0.22	0.18	0.26	0.23	0.31	0.32	0.31	0.32	0.00
Number of days / year salinity <8 or >28 ppt	0.40	0.13	0.13	0.00	0.37	0.13	0.40	0.13	0.13	0.37	0.13	0.37	0.37	0.37	0.37	0.00
Total $ over 50 years	24	245	117	1	141	362	25	246	118	142	363	269	386	270	387	0

The team analyzed the alternatives portfolio with the conceptual system model to determine how each alternative performed in relation to each objective.

Weighted Objectives

High Climate Change Scenario

		Alternatives														
Suggested Measurable Attribute	**Weight**	**Natural 1**	**Natural 2**	**Engineering**	**Sea Level Rise (SLR)**	**Natural 1 + Engineering**	**Natural 2 + Engineering**	**Natural 1 + SLR**	**Natural 2 + SLR**	**Engineering + SLR**	**Natural 1 + Engineering + SLR**	**Natural 2 + Engineering + SLR**	**Natural 1 + Natural 2**	**Natural 1 + Natural 2 + Engineering**	**Natural 1 + Natural 2 + SLR**	**Everything**	**Status Quo**
River miles with salinity <3 ppt	0.30	0.42	0.39	0.35	0.14	0.52	0.52	0.40	0.42	0.38	0.52	0.53	0.57	0.63	0.57	0.65	0.00
# days when water depth outside useable levels	0.07	0.33	0.32	0.25	0.00	0.40	0.35	0.33	0.32	0.25	0.40	0.35	0.45	0.51	0.45	0.51	0.00
# days algae concentration above threshold	0.07	0.38	0.33	0.33	0.00	0.41	0.37	0.38	0.33	0.33	0.41	0.37	0.43	0.52	0.43	0.52	0.00
# of days turbidity above threshold	0.07	0.25	0.22	0.18	0.00	0.26	0.23	0.25	0.22	0.18	0.26	0.23	0.31	0.32	0.31	0.32	0.00
Number of days / year salinity <8 or >28 ppt	0.20	0.40	0.13	0.13	0.00	0.37	0.13	0.40	0.13	0.13	0.37	0.13	0.37	0.37	0.37	0.37	0.00
Total $ over 50 years	0.30	0.94	0.37	0.70	1.00	0.64	0.06	0.94	0.36	0.70	0.63	0.06	0.30	0.00	0.30	0.00	1.00
Weighted Score		**0.55**	**0.31**	**0.39**	**0.34**	**0.49**	**0.26**	**0.54**	**0.32**	**0.40**	**0.49**	**0.27**	**0.41**	**0.35**	**0.41**	**0.36**	**0.30**

Once each alternative was ranked, the team weighted the objectives to determine which alternative would be the best performing. Several sea level rise scenarios were analyzed to determine if any alternative performed better, or was robust, across the range of possible futures.

Plan Selection

- Based on a series of scenarios it was determined that the $Natural_1$ alternative consistently ranked either highest or among the top two alternatives.
- The addition of a submerged weir improved the performance of each alternative slightly.
- Combining multiple alternatives provided for improved performance but also increased cost considerably.

Selected Plan

- Based on the results of our analysis Natural$_1$ was selected as our preferred alternative.
  - This alternative met all of the project objectives.
  - This alternative was the least cost alternative.
  - The alternative was scalable and additional storage could be added in the future if necessary.
  - Additional alternatives could be easily added to it if needed.